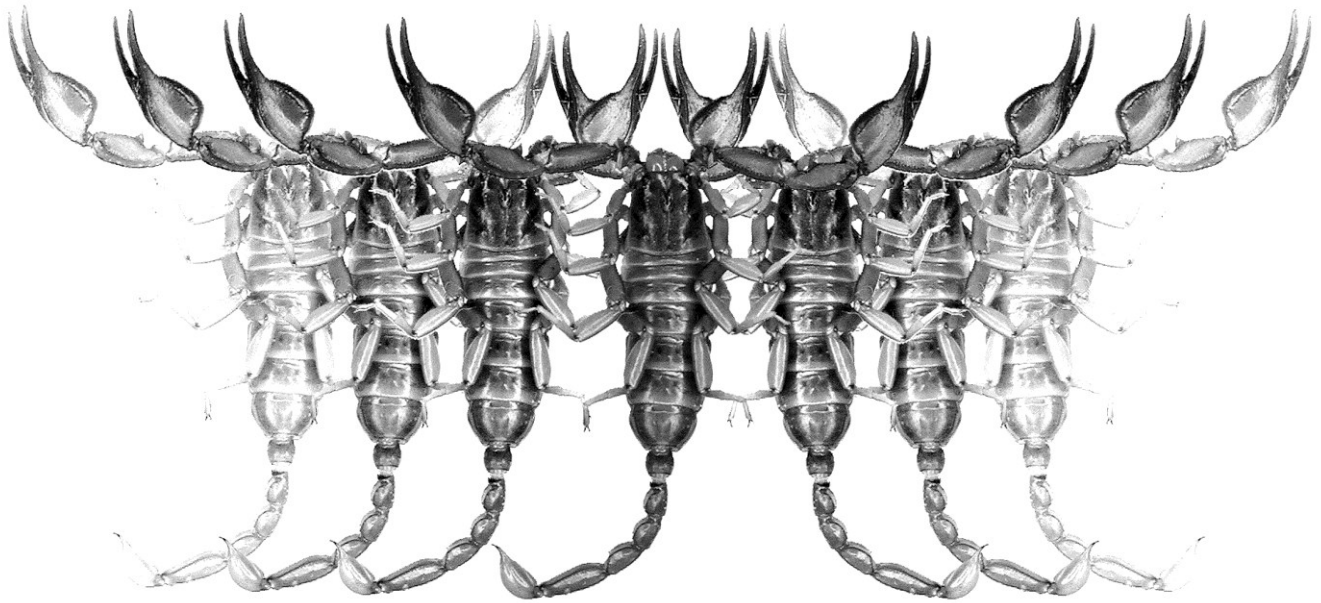


Euscorpius

Occasional Publications in Scorpiology



**A New Species of *Vaejovis* from the Mogollon Rim
of Northern Arizona (Scorpiones: Vaejoidea)**

Richard F. Ayrey

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Euscorpius

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<http://zoobank.org/urn:lsid:zoobank.org:pub:DB56A05A-2608-4C56-96BF-1D443A8F9D81>

A new species of *Vaejovis* from the Mogollon Rim of northern Arizona (Scorpiones: Vaejovidae)

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<http://zoobank.org/urn:lsid:zoobank.org:pub:DB56A05A-2608-4C56-96BF-1D443A8F9D81>

Summary

A new scorpion species, *Vaejovis trinityae* **sp. nov.** is described. This small brown species is found along the Mogollon Rim above Strawberry, Arizona. This is the first description of a new species of the “*vorhiesi*” group scorpions whose DNA phylogenetic analysis was published (Bryson et al., 2013); based on DNA data, the new species is most related to *V. lapidicola* Stahnke and *V. crumpi* Ayrey et Soleglad. It represents one of the “twenty-seven geographically cohesive lineages inferred from the mtDNA tree”. A unique characteristic of this species is that it exhibits arboreal behavior, being frequently found on Ponderosa pine trees.

Introduction

Including the new species described in this paper from the Mogollon Rim above Strawberry, Arizona, there are now 15 “*vorhiesi*” group species in the USA (Arizona, New Mexico, and Utah), and Mexico (Sonora). Until now, they have all been found in sloping, lithophilic habitats. *Vaejovis trinityae* **sp. nov.** is the first species of the “*vorhiesi*” group to be found in a non lithophilic habitat and a predominately arboreal microhabitat (Ponderosa Pine trees), due to lack of vertical rock surfaces in their environment.

Recent phylogenetic analysis based on DNA markers (Bryson et al., 2013) is consistent with the morphometric evidence and confirms that a new species represents an isolated evolutionary lineage. Based on the DNA data, it is most closely related to *V. crumpi* and *V. lapidicola* but these three lineages diverged approximately 4.43 million years (Bryson et al., 2013). This is the first, though not the last, formal description of one of the 16 lineages inferred by Bryson et al. (2013). I expect that the “*vorhiesi*” group of the genus *Vaejovis* will be the largest species group in the Vaejovidae.

Materials and Methods

Terminology and conventions

Measurements are as described in Stahnke (1970), trichobothrial patterns are as in Vachon (1974), and pedipalp finger dentition follows Soleglad & Sissom (2001). The holotype (USNM) was sequenced by Bry-

son et al. (2013) and therefore constitutes a genseq-1 COI, 16S, ITS2, 28S (nomenclature for reporting DNA sequences from types suggested by Chakrabarty et al., 2013).

Abbreviations

RFA, personal collection of Richard F. Ayrey, Flagstaff, Arizona, USA; MES, personal collection of Michael E. Soleglad, Winchester, California, USA; CNAN, Colección Nacional de Arácnidos, Instituto de Biología, Universidad Nacional Autónoma de México, D.F., Mexico; UANL, Universidad Autónoma de Nuevo León, San Nicolas de los Garza, Nuevo León, Mexico; and USNM, United States National Museum, Smithsonian Institution, Washington, DC, USA.

Material

Besides type material listed below under new species description, the following additional specimens were examined:

Vaejovis trinityae sp. nov. USA: Arizona: along the Mogollon Rim, Coconino County, Arizona (N34.5201°, W111. 5074°), 1924 m asl, 31 August 2008, leg. R.F. Ayrey, 1 ♂, 4 ♀ (RFA); same locality, 31 May 2009, leg. R. F. Ayrey & M. DeBoer-Ayrey, 8 ♀ (RFA); same locality, 14 August 2010, leg. R. F. Ayrey & M. DeBoer-Ayrey, 8 ♀ (RFA); same locality, 16 September 2011, leg. R. F. Ayrey & M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); same locality, 17 October 2011, leg. R. F. Ayrey & M. DeBoer-Ayrey, 1 ♀ (RFA); same locality, 18 May 2012, leg. R. F. Ayrey & M. DeBoer-Ayrey, 2 ♂, 2 ♀ (RFA).

Vaejovis bandido Graham, Ayrey et Bryson, 2012. Mexico: Sonora: Sierra de los Ajos Mountains, 12–13 October 2010, leg. R.W. Bryson, Jr., 3 ♂ (1 CNAN, 2 UANL), 3 ♀ (1 CNAN, 2 UANL).

Vaejovis brysoni Ayrey et Webber, 2013. USA: Arizona: Pima Co.: above Molino Basin on Catalina Highway near Seven Cataracts Vista, Santa Catalina Mountains. 16 March 2012, leg. R.W. Bryson, Jr., 1 ♂, 7 ♀ (RFA); 5 April 2012, leg. R.W. Bryson, Jr. & D. Hartman, 8 ♀ (RFA); same locality, 18 August 2012, leg. R. F. Ayrey & M. DeBoer-Ayrey, 8 ♀ (RFA).

Vaejovis cashi Graham, 2007. USA: Arizona: Cochise Co.: Cave Creek Canyon, Chiricahua Mountains, 2 August 2008, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA); same locality, 23 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 4 ♀ (RFA).

Vaejovis crumpi Ayrey et Soleglad, 2011. USA: Arizona: Yavapai Co.: near Lynx Lake, Prescott, 14 August 2008, R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀ from type locality (RFA); same locality, 14 September 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA); same locality, 8 August 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey 3 ♂, 5 ♀ (RFA).

Vaejovis deboerae Ayrey, 2009. USA: Arizona: Pima Co.: Rose Canyon Campground, Santa Catalina Mountains, 28 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀ (RFA); same locality, 29 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA).

Vaejovis electrum Hughes, 2011. USA: Arizona: Graham Co.: Upper Arcadia Campground, Mt. Graham. 17 July 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); Mt Graham Hwy, Mt. Graham, 9415 feet asl, 18 July 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 4 ♀ (RFA).

Vaejovis feti Graham, 2007. USA: New Mexico: Meadow Creek, Black Mountains, 6 July 1978, leg. M. H. Muma 4 ♂, 3 ♀ (MES).

Vaejovis halli Ayrey, 2012. USA: Arizona: Gila Co.: Mount Ord, 11 September 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀, paratypes (RFA); same locality, 2 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀, paratypes (RFA).

Vaejovis jonesi Stahnke, 1940. USA: Arizona: Coconino County: near Wupatki National Monument, 1 April 2011, leg. R. F. Ayrey, 1 ♀ from type locality (RFA).

Vaejovis lapidicola Stahnke, 1940. USA: Arizona: Coconino County: Red Sandstone Quarry, Flagstaff, 1 June 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA).

Vaejovis sp. cf. *lapidicola* (“Strawberry” population in Bryson et al., 2013). USA: Arizona: Coconino County, along the Mogollon Rim, 1924 m asl, 31 August

2008, leg. R.F. Ayrey, 1 ♂, 4 ♀ (RFA); same locality, 31 May 2009, leg. R. F. Ayrey & M. DeBoer-Ayrey 8 ♀ (RFA); same locality, 14 August 2010, leg. R. F. Ayrey & M. DeBoer-Ayrey, 8 ♀ (RFA); same locality, 16 September 2011, leg. R. F. Ayrey & M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); same locality, 17 October 2011, leg. R. F. Ayrey & M. DeBoer-Ayrey, 1 ♀ (RFA); same locality, 18 May 2012, leg. R. F. Ayrey & M. DeBoer-Ayrey, 2 ♂, 2 ♀ (RFA).

Vaejovis paysonensis Soleglad, 1973. USA: Arizona: Coconino County: Control Road, 25 miles E of Payson. 5 July 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA); same locality, 6 July 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA).

Vaejovis tenuipalpus Sissom et al., 2012. USA: Arizona: Mojave Co.: Getz Peak, Hualapai Mountains, 9 August 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ (RFA).

Vaejovis vorhiesi Stahnke, 1940. USA: Arizona: Cochise Co.: Miller Canyon, Huachuca Mountains, 24 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA); Carr Canyon, Huachuca Mountains, 5 October 2008, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); Garden Canyon, Huachuca Mountains, 26 August 2011, leg. R. F. Ayrey, 4 ♂, 6 ♀ (RFA); Lutz Canyon, Huachuca Mountains, 27 March 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 2 ♀ (RFA); Ash Canyon, Huachuca Mountains. 24 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♀ (RFA).

Vaejovis sp. cf. *vorhiesi* (“Santa Rita” population in Bryson et al., 2013). USA: Arizona: Cochise Co.: Madera Canyon, Santa Rita Mountains, 11 June 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ (RFA); Mount Hopkins, Santa Rita Mountains, 6 October 2009, leg. R. F. Ayrey, T. Miscione & R. Troup, 2 ♂, 6 ♀ (RFA).

Vaejovis sp. cf. *vorhiesi* (“Whetstone” population in Bryson et al., 2013). USA: Arizona: Cochise Co.: French Joe Canyon, Whetstone Mountains, 14 October 2009, leg. R. Troup, 1 ♀ (RFA).

Systematics

Order SCORPIONES C. L. Koch, 1850

Family Vaejovidae Thorell, 1876

Subfamily Vaejovinae Thorell, 1876

Vaejovis trinityae Ayrey, sp. nov.

(Figs. 1–13; Tables 1–2)

<http://zoobank.org/urn:lsid:zoobank.org:act:670320DB-F16C-4209-98AF-2773956248E4>

Diagnosis. Small (23.55 mm) scorpions. Color is brown, lighter on the legs, with underlying mottling on



Figures 1–2: *Vaejovis trinityae* sp. nov. female and male paratypes in natural habitat.



Figure 3: *Vaejovis trinityae* sp. nov. holotype female dorsal and ventral views.

carapace and mesosoma. (see Figure 1). Pedipalp movable finger usually with 7 *ID* denticles and fixed finger usually with 6. Carapace of female is longer than the fifth metasomal segment. Pectinal tooth count for females 11.72 [*n* = 32], males 13.00 [*n* = 10]. Small, obsolete subaculear tubercle.

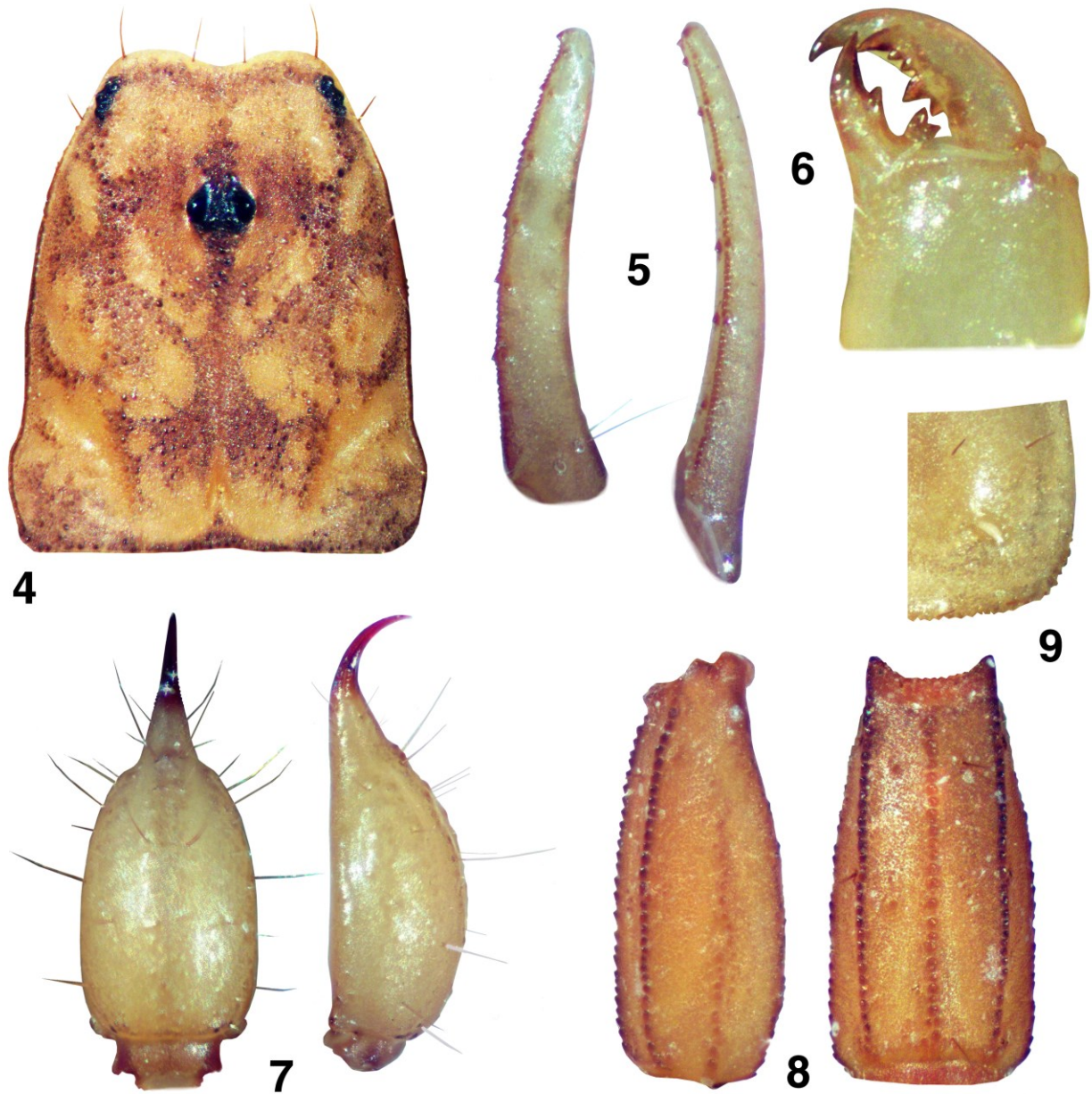
Type material. Holotype ♀, (N34.5201°, W111.5074°), USA: Arizona: Coconino County, Mogollon Rim, 11 September 2011, leg. R.F. Ayrey, specimen RA269 (USNM). Paratypes: same locality, 16 Sep-

tember 2011, leg. R.F. Ayrey, 2 ♂ (RA580, RA581), 2 ♀ (RA579, RA583) (RFA).

Etymology. This species is named in honor of Trinity Frances Ayrey, my granddaughter and inspiration.

Distribution. Known only from the type locality: USA: Arizona: Coconino County, Mogollon Rim.

Description. Based on holotype female, unless otherwise noted. See Fig. 3 for dorsal and ventral views and



Figures 4–9: *Vaejovis trinityae* sp. nov. paratype male. 4. Carapace. 5. Dentition of fixed and movable fingers of chela. 6. Chelicera, dorsal view. 7. Telson, ventral and lateral views. 8. Metasomal segment V, lateral and ventral views. 9. Stigma IV, left side.

Table 1 for measurements of holotype and four paratypes.

Color. Color is brown, lighter on the legs. Faint underlying mottling on the carapace and mesosoma.

Carapace (Fig. 4). Anterior margin of carapace moderately emarginated, posterior margin slightly emarginated. Carapace finely granular. Three lateral eyes on each side. Median furrow moderate and traverses entire

length of carapace. Ratio of median eyes location from anterior edge/carapace length 0.69; carapace length/width at median eyes 1.43. Carapace of female is longer than metasomal segment V.

Mesosoma (Fig. 9). Tergites finely granular with vestigial median carina on Tergites I–VI. Tergite VII with weak median carina on anterior third and strong dorsal lateral and lateral supramedian granular carinae. Sternites III–VI finely granular and without carinae. Sternite

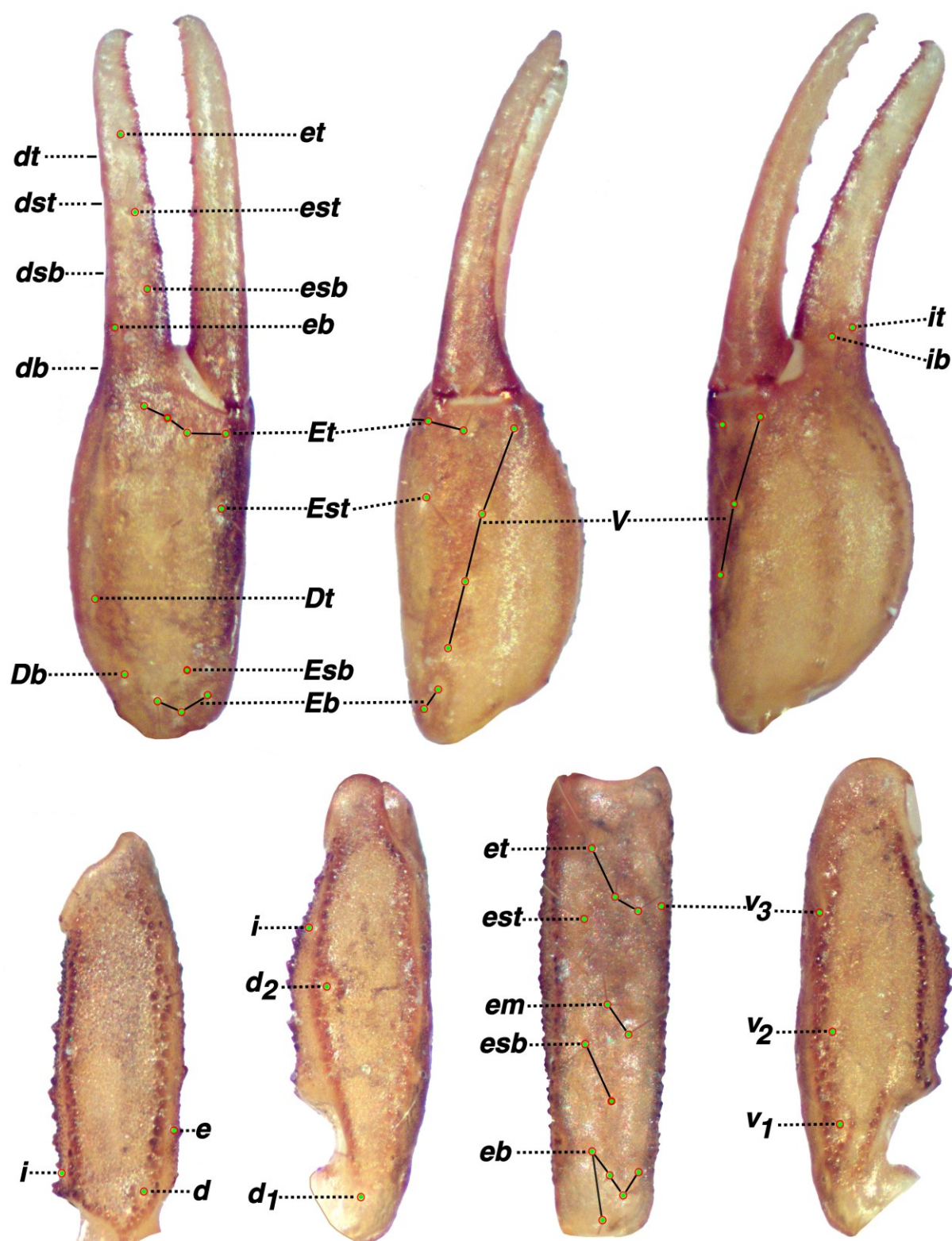


Figure 10: *Vaejovis trinityae*, sp. nov., paratype male. Trichobothrial pattern.

VII with granular ventral lateral carinae on middle third. Presternites smooth. Spiracles ovoid with median side rotated 35° from posterior sternite margin. Sternites with variable number of microsetae.

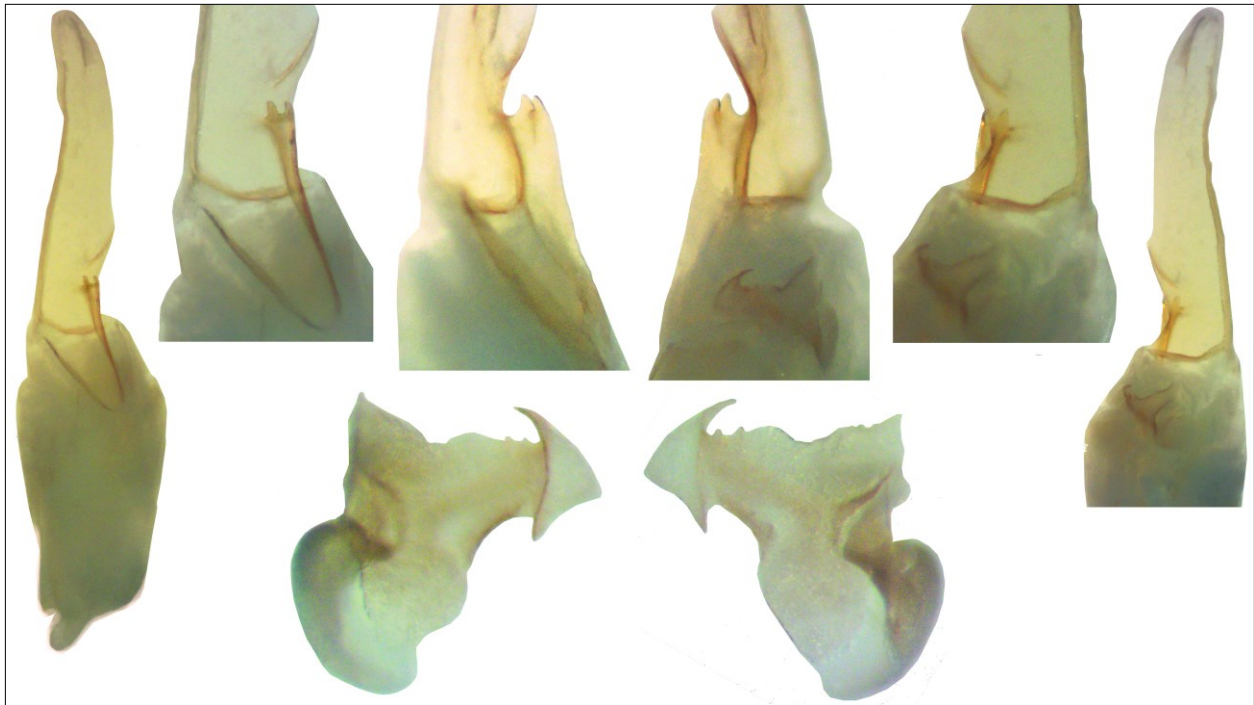


Figure 11: Right hemispermatophore and mating plug of *Vaejovis trinityae*, **sp. nov.**, paratype male (photographed submerged in alcohol). **Left.** Dorsal view. **Upper Left.** Closeup of median area, dorsal and externodorsal views. **Right.** Ventral view. **Upper Right.** Closeup of median area, internoventral and ventral views. **Bottom.** Mating plug, dorsal and ventral views, showing smooth barb (in dorsal view). Note in all ventral views of the hemispermatophore the embedded mating plug is visible, the barb positioned towards the internal edge. Due to the translucency of the lamina, the ventral trough edge is visible from the dorsal view and the bifurcated lamellar hook, which emanates from the dorsal trough edge, is visible from the ventral view.

Sternum. Sternum is type 2 (Soleglad & Fet, 2003) and is wider than long.

Genital Operculum. Sclerites separated on posterior one-fifth.

Pectines. Pectinal tooth count for the holotype female 10/10 and 14/15 for the paratype male. All pectinal teeth have exterodistal angling with large sensorial area. Middle lamellae 6/6. Fulcra are present. Each fulcrum with one central seta.

Metasoma (Fig. 8). Carapace of female is longer than the fifth metasomal segment. Ratio of segment I length/width 0.74; of segment II length/width 0.97; of segment III length/width 0.99; of segment IV length/width 1.34; of segment V length/width 2.05. Segments I-IV: dorso-lateral carinae moderate, granular. Lateral suprmedian carinae I-IV strong and granular with enlarged spinoid distal denticle on I & II. Lateral inframedian carinae moderately granular on segment I, posterior 3/5 of II, 2/5 of III, and obsolete on IV. Ventrolateral carinae I weak and granular; on II-III moderate, granular; on IV strong, granular. Ventral submedian carinae weak to moderate on segment I, moderate on II, moderate, granular on III and moderate to strong, granular on IV. Dorsal and lateral intercarinal spaces very finely granular. Segment

I-IV ventral submedian setae 3/3. Segment V: Dorso-lateral carinae weak, distally crenulate, basally granular. Lateromedian carinae moderate, granular. Ventrolateral and ventromedian carinae moderate. Intercarinal spaces finely granular. Segment V ventrolateral setae 4/4.

Telson (Fig. 7). Smooth with 4 pairs of large setae on the ventral surface, 3 large setae along both lateral edges of the vesicle and numerous smaller setae. Small, obsolete subaculear tubercle present.

Chelicerae (Fig. 6). Dorsal edge of movable cheliceral finger with two subdistal (sd) denticles. Ventral edge is smooth, with well developed serrula on distal half.

Pedipalps (Figs. 5, 10). Trichobothrial pattern type C (Vachon, 1974) (see Fig. 10). Trichobothria *ib* and *it* located at base of fixed finger. Pedipalp ratios: chela length/width 3.88; femur length/width 3.39; patella length/width 3.14; fixed finger length/carapace length 0.72.

Chela (Fig. 5). Carinae moderate. Fixed finger with median (*MD*) denticles aligned and divided into 6 subrows by 5 outer (*OD*) denticles and usually 6 *ID* denticles. Movable finger with 6 subrows, 5 *OD* denti-

<i>V. trinitiae</i>					
	Female holotype #269	Female paratype #579	Female paratype #583	Male paratype #581	Male paratype #580
Total length	23.55	25.34	25.25	17.89	16.65
Carapace length	3.20	3.39	3.51	2.38	2.34
Mesosoma length	7.89	9.34	7.82	5.26	4.96
Metasoma length	9.47	9.52	10.69	7.95	7.26
Segment I length/width	1.24/1.68	1.15/1.91	1.43/1.76	1.03/1.43	0.95/1.42
Segment II length/width	1.47/1.51	1.51/1.79	1.64/1.71	1.18/1.38	1.09/1.31
Segment III length/width	1.52/1.54	1.64/1.76	1.84/1.60	1.35/1.29	1.30/1.20
Segment IV length/width	2.14/1.60	2.18/1.68	2.46/1.53	1.88/1.23	1.76/1.19
Segment V length/width	3.10/1.51	3.04/1.71	3.32/1.49	2.51/1.10	2.16/1.05
Telson length	2.99	3.09	3.23	2.30	2.09
Vesicle length	1.92	1.97	2.04	1.43	1.41
width/depth	1.01/0.96	1.12/1.12	1.08/1.02	1.43/0.86	1.35/0.84
Aculeus length	1.07	1.12	1.19	0.87	0.90
Pedipalp length	10.34	11.32	11.10	8.01	7.88
Femur length/width	2.71/0.80	2.89/0.93	2.74/0.86	2.18/0.66	2.16/0.62
Patella length/width	3.01/0.96	3.21/0.99	3.32/0.97	2.31/0.72	2.26/0.67
Chela length	4.62	5.02	5.04	3.52	3.39
Palm length	1.98	2.41	2.10	1.58	1.52
width/depth	1.19/1.09	1.26/1.19	1.22/1.02	0.87/0.80	0.84/0.81
Fixed finger length	2.31	2.80	2.71	1.80	1.73
Movable finger length	2.68	3.20	3.38	2.18	2.06
Pectines teeth	10-10	11-11	14-13	14-15	14-14

Table 1: Morphometrics (mm) of *Vaejovis trinitiae*, sp. nov.

cles and usually 7 *ID* denticles (Soleglad & Sissom, 2001).

Femur. Carinae moderate.

Patella. Carinae strong, internal surface with very large granules on the *DPSc* carina.

Legs. Ventral surface of tarsomere II with single median row of spinules terminating distally with one spinule pair.

Hemispermaphore (Fig. 11). The hemispermaphore is lightly sclerotized with subparallel lamellar edges, with slight tapering distally. On the dorsal surface a distal crest is present on the inner distal aspect of the lamella, which is also visible from the ventral surface. The lamellar hook, which is moderately sclerotized, is of medium length, emanating from the dorsal trough, and is widely bifurcated. The lamellar hook is somewhat lon-

ger than typically seen in other “*vorhiesi*” group species, exhibiting a ratio of 0.343 when the lamellar hook is compared to the lamina length. A weak, subtle truncal flexure is visible on the external aspect of the trunk/lamella juncture. A slightly sclerotized mating plug was located on the ventral surface, on the internal area just below the ventral trough. Its stock is somewhat thick and the barb’s ventral edge is smooth. The mating plug, still embedded in the median area, is visible from the ventral surface in Fig. 11.

Variability. Variability of fixed finger *ID* denticle count was noted in *V. trinitiae*. The counts were 6 (n=16) and 5 (n=4). Variability of pectinal tooth counts was also noted with the average for females 11.719 (n=32) and males 13.0 (n=10).

Type Locality. The type specimens were found, using a blacklight at night along the Mogollon Rim, Coconino County, Arizona (N34.5201°, W111.5074°) at an eleva-



Figures 12–13: *Vaejovis trinityae* sp. nov. 12 (top). Habitat. 13 (bottom). Paratype female with newborn.

		<i>V. trinityae</i> Female Morphometric Ratio Comparisons					
	<i>V. trinityae</i> (3)	<i>V. bigelowi</i> (1)	<i>V. crumpi</i> (3)	<i>V. jonesi</i> (1)	<i>V. lapidicola</i> (3)	<i>V. paysonensis</i> (1)	<i>V. tenuipalpus</i> (3)
Total length	23.55–25.34	<u>27.84</u>	<u>25.53–27.56</u>	<u>44</u>	<u>28.5–28.7</u>	<u>26.95</u>	<u>28.38–31.24</u>
Carapace length	3.20–3.39	<u>3.61</u>	3.18–3.40	<u>5.00</u>	<u>4.1–4.3</u>	<u>3.56</u>	<u>3.52–3.71</u>
CA_L/MetV_L	1.03–1.12	<u>0.97</u>	<u>0.92–0.94</u>	<u>0.91</u>		<u>1.00</u>	<u>0.93–0.98</u>
Segment I length/width	0.60–0.81	<u>0.93</u>	0.76–0.84	<u>0.92</u>	<u>0.86</u>	<u>0.90</u>	<u>0.90–0.94</u>
Segment II length/width	0.84–0.97	<u>1.07</u>	0.86–1.00	-	<u>1.08</u>	<u>1.00</u>	<u>1.09–1.18</u>
Segment III length/width	0.93–1.15	<u>1.21</u>	1.05–1.14	-	<u>1.17</u>	1.14	<u>1.29–1.36</u>
Segment IV length/width	1.30–1.61	1.60	1.40–1.53	-	1.61	1.59	<u>1.74–1.83</u>
Segment V length/width	2.05–2.23	<u>2.27</u>	2.13–2.27	<u>2.50</u>	-	2.13	<u>2.49–2.52</u>
Telson Vesicle Length/width	1.76–1.90	1.76	<u>1.67–1.75</u>	-	-	<u>1.44</u>	1.60–1.77
Femur length/width	3.11–3.39	<u>3.48</u>	<u>2.56–2.84</u>	-	3.31	3.21	<u>3.81–3.83</u>
Patella length/width	3.14–3.42	3.39	<u>2.87–2.95</u>	-	3.19	3.25	<u>3.72–3.85</u>
Chela length/width	3.88–4.13	<u>4.21</u>	3.82–4.11	-	<u>4.73</u>	4.07	<u>5.05–5.43</u>
FF_L/CA_L	0.72–0.83	0.83	0.72–0.79	<u>0.66</u>	-	0.74	0.83–0.87
FF_L/CA_L	0.50–0.56	0.52	0.48–0.51	-	-	0.50	0.50–0.51
Pectinal Teeth	10–14 (11.72) [32]	10 (10) [2]	10–11 (10.80) [10]	13 (13.00) [2]	11–13 (12.00) [6]	11–12 (11.50) [2]	10–12 (11.17) [6]

Table 2: Morphometrics (mm) of female *V. trinityae* versus other select “*vorhiesi*” group species. **Bold underlined** comparisons are those for which there is no overlap with *V. trinityae* sp. nov. *V. lapidicola* data from the original description and redescription (Stahnke, 1940 & Graham, 2006). Pectinal tooth count data stated as min-max (mean) [N]. Number in parentheses following species name is number of samples used in the morphometric comparisons. CA_L = carapace length, FF_L = fixed finger length.

tion of 1924 m asl. The vegetation type is mesic Ponderosa Pine and mixed evergreen oak woodland. As can be seen in Fig. 5, there is very little slope to the terrain. No other scorpions were found syntopically with *V. trinityae* during eight field trips to the Mogollon Rim.

Behavior. This species is the only member of the lithophilic “*vorhiesi*” group that does not live in a sloping and frequently vertical rock habitat. Within their habitat (Fig. 12) the only vertical surfaces are trees. New species appears to use the trees, usually Ponderosa pine, both living and dead, to take advantage of the heat that is absorbed on the vertical surfaces from the sun. Cracks in the bark of these trees also provide retreats. The author

has seen and collected at least 17 species of sky island *Vaejovis*. This is the first time that he has seen them frequently using trees as substrate. Almost half of the specimens collected were found between one and 18 inches up, on the southeast facing surface of the bark of the trees (142°). The second most common location was under dead bark lying on the ground, with the rest found in the open.

Comparison

Map in Fig. 14 shows the type localities of the 15 currently described “*vorhiesi*” group species of *Vaejovis* from Arizona, New Mexico, Utah, and Sonora, Mexico.

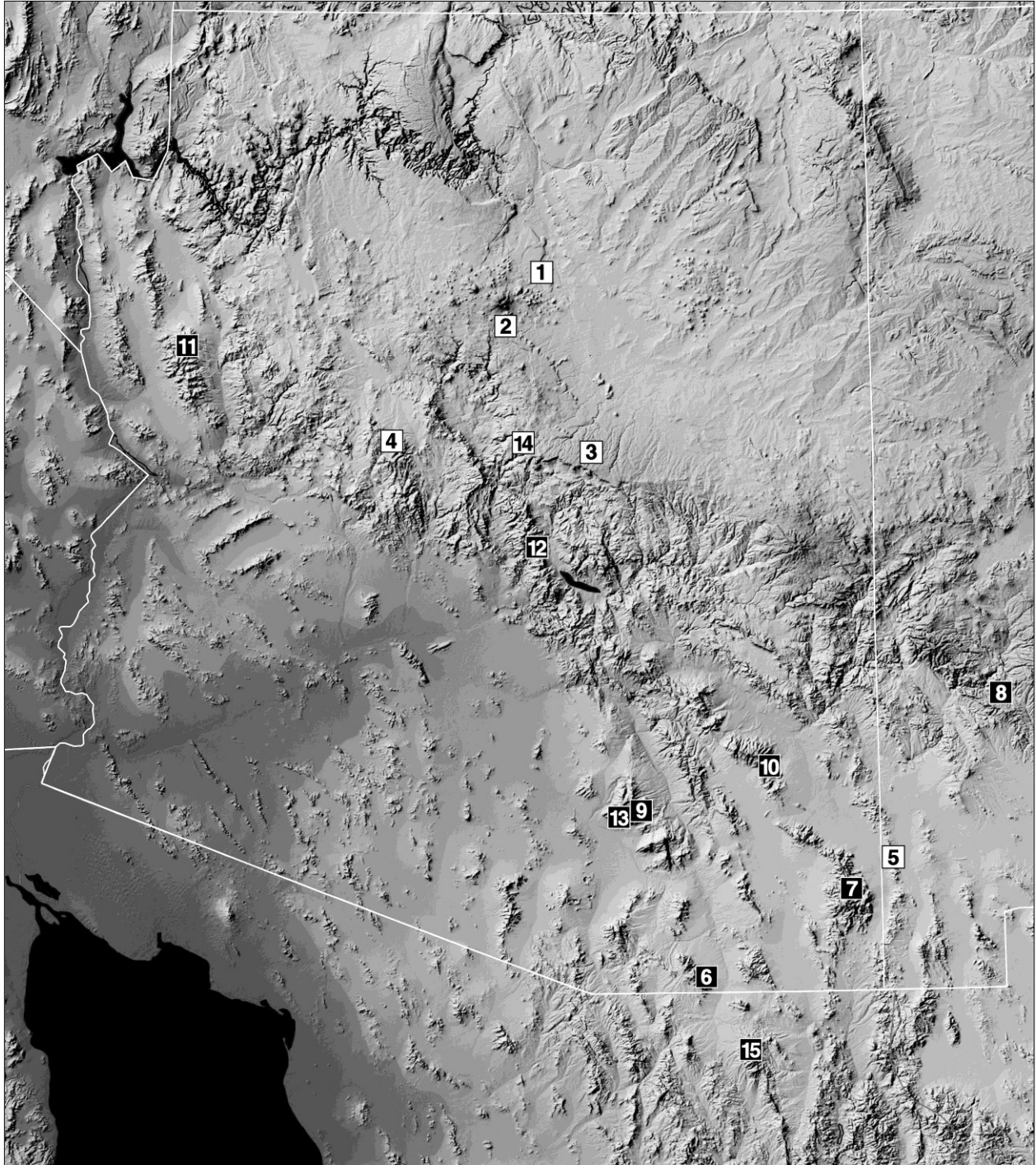


Figure 14: Map of Arizona, extreme western New Mexico and northern Sonora showing the type localities of the fifteen *Vaejovis vorhiesi* group species discussed in this paper, including new species *Vaejovis trinityae*. Localities are divided into those species exhibiting seven inner denticles (*ID*) on the chelal movable finger (white rectangles with black lettering) and those with primarily six, or five *ID* denticles (black rectangles with white lettering). **Seven *ID*s:** 1 = *V. jonesi*, 2 = *V. lapidicola*, 3 = *V. paysonensis*, 4 = *V. crumpi*, 5 = *V. bigelowi*, 14 = *V. trinityae* sp. nov. **Six *ID*s:** 6 = *V. vorhiesi*, 7 = *V. cashi*, 8 = *V. feti*, 9 = *V. deboerae*, 10 = *V. electrum*, 11 = *V. tenuipalpus*, 12 = *V. halli*, 13 = *V. brysoni*, and 15 = *V. bandido*.

Comparisons are made to all species with emphasis on *V. lapidicola* and *V. crumpi*, due to recent DNA-based phylogenetic analysis (Bryson et al., 2013).

Vaejovis bandido, *V. brysoni*, *V. cashi*, *V. deboerae*, *V. electrum*, *V. feti*, *V. halli* and *V. vorhiesi* all exhibit 6 inner denticles (*ID*) on the chela movable fin-

ger, not 7 as found on most northern Arizona “vorhiesi” group scorpions, including *Vaejovis trinityae*. Recent DNA analysis (Bryson et al., 2013) estimates that the lineage represented by *V. trinityae* diverged from the clade that includes abovelisted species 16.26 million years ago (Mya). We compare these species below, refer to Table 2 for statistical data.

***Vaejovis jonesi*:** Based on the original description by Stahnke (1939), *V. jonesi* is a much larger species, total length approximately 75% larger and carapace length approximately 50 % larger than *V. trinityae*. Three ratio comparisons can be made between the original female measurements and the measurements of *V. trinityae*, all three of which do not overlap with *V. trinityae* (see Table 2). Recent DNA analysis (Bryson et al., 2013) estimates that lineages represented by *V. trinityae* and *V. jonesi* diverged 15.37 Mya. *V. trinityae* is also widely allopatric with *V. jonesi*.

***Vaejovis paysonensis*:** Compared to the remaining male and female from the original set used to describe the species (Soleglad, 1973) *V. trinityae* is smaller than *V. paysonensis* and there is no overlap in 4 important morphometric ratios (see Table 2). Recent DNA analysis (Bryson et al., 2013) estimates that lineages represented by *V. trinityae* and *V. paysonensis* diverged 13.45 Mya.

Vaejovis bigelowi differs from *V. trinityae* by being larger and by 7 important morphometric ratios (see Table 2). This is the only species for which there is no DNA data available at this time. It is also widely allopatric with *V. trinityae*.

Vaejovis tenuipalpus has 6 ID denticles on both the fixed and movable fingers while *V. trinityae* has 7 ID denticles on the movable finger. *V. tenuipalpus* is also larger and differs from *V. trinityae* by 9 important morphometric ratios (see Table 2). Recent DNA analysis (Bryson et al., 2013) estimates that lineages represented by *V. trinityae* and *V. tenuipalpus* diverged 14.31 Mya. *V. trinityae* is also widely allopatric with *V. tenuipalpus*.

***Vaejovis lapidicola*:** The male *V. lapidicola* has a “planate” carapace (Graham, 2007; Ayrey & Soleglad 2012) whereas the male of *V. trinityae* has a carapace that tapers gradually like *V. crumpi* and the other described “vorhiesi” group species (see Fig. 2). *V. lapidicola* is a larger species, females are 16% larger, with no overlap in total length, carapace length or metasoma length with *V. trinityae*. There is also no overlap in female metasomal segment I, II, and III L/W ratios as well as chela L/W ratio. Recent DNA analysis (Bryson et al., 2013) estimates that lineages represented by *V. trinityae* and *V. lapidicola* diverged 4.43 Mya.

Vaejovis crumpi is larger than *V. trinityae* and the carapace is shorter than metasomal segment V, longer in *V. trinityae*. Both the femur and patella of *V. crumpi* are thicker compared to *V. trinityae* and the telson vesicle is relatively thicker (see Table 2). Recent DNA analysis (Bryson et al., 2013) estimates that lineages represented

by *V. trinityae* and *V. crumpi* diverged 4.43 Mya. *V. trinityae* is also widely allopatric with *V. crumpi*.

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